Prediction of cereal feed value by near infrared spectroscopy

Johannes Ravn Jørgensen, Aarhus University, Faculty of Agricultural Sciences, Dept. of Genetics and Biotechnology
Forsøgsvej 1, DK-4200 Slagelse, Denmark. (johannes.jorgensen@agrsci.dk)

Introduction

The interest in the value of wheat and barley for animal feed has increased with the recognition that there is a significant variation in yields as well as the quality of the harvested feed grain. This variation is found between varieties as well as due to an environmental variation between regions and the harvest year. The feed value is described primarily by: Feed value in form of FEsv (Feed unit / kg dry matter, for piglets) and FEso (Feed unit / kg dry matter, for sows), EDOM (Enzyme Degradable Organic Matter) and EDOMi (Enzyme Degradable Organic Matter, Ileum). The chemical analysis is, however, time-consuming and costly, and it is therefore desirable to have a rapid and less expensive method, which makes it possible to carry out more analyses in-situ.

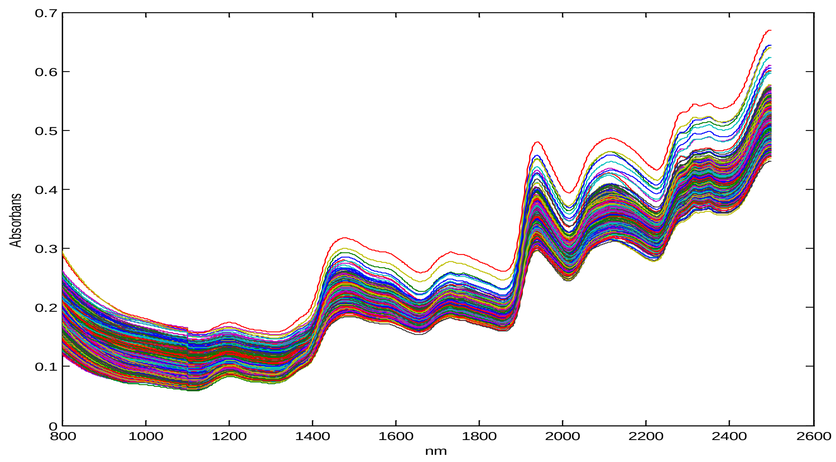
Near infra-red reflection spectroscopy (NIRS) is appropriate as a standard analysis of dry matter, total N, starch and is today used routinely by grain traders. NIRS is therefore appropriate as a quick method for the determination of FEsv and FEso, since it is rapid (approximately 1 minute per measurement of a ground test) and cheap.

Aim

The aim is to develop a rapid method to analyse grain feed value. This will contribute to highlight the opportunities and problems that crop variety choices and cropping practices have on feeding value of winter wheat, triticale and spring barley. A successful development of an EDOM, EDOMi, FEso and FEsv calibration to NIRS will be a relatively cheap tool to monitor, diversify and evaluate the quality of cereals for animal feed, a possible tool to assess the feed value of new varieties in the variety testing and a useful, cheap and rapid tool for cereal breeders.

Method

A bank of 1213 grain samples of wheat, triticale, barley and rye, and related chemical reference analyses to describe the feed value have been established. The samples originate from available field trials over a three-year period. The chemical reference analyses are dry matter, crude protein, crude ash, crude oils and fats, EDOM, EDOMi, FEso and FEsv. All samples were ground on a laboratory mill and scans were obtained using a QFA-Flex 400 FT-NIR instrument.



Results

It has been a challenge to develop a NIRS method to determine feed value, as it has been shown that the chemical reference analysis has been subject to considerable error. Despite this, it has been possible to develop a wide-ranging calibration model predicting the feed value FEsv and FEso for wheat, barley and triticale. Status of the developed model is a SEP (standard error of performance) of 1.7% for EDOM, 1.7% for EDOMi, 2.2% for FEsv and of 1.8% for FEso. For the assessment of method repeatability in relation to the chemical uncertainty of feed value, the prediction error has to be compared with the error in the chemical analysis. Prediction error by NIRS prediction of feed value has been shown to be above the error of the chemical measurement.

Table 1. Cereal feed value. Universal model – wheat, barley, triticale and rye. Calibration model based on grain samples harvested in 2005, 2006 and 2007

	n	*r*	RMSEP	Range
Protein	1155	0.94	0.51	6.5-15.5
EDOM	1175	0.88	1.48	80.0-94.0
EDOMi	1164	0.84	1.48	74.0-90.0
FEsv	1166	0.89	2.43	96-121
FEso	1006	0.89	1.98	98-118

Model: 1d MSC NIR spectre, cross validated
r: Pearson's correlation coefficient
RMSEP: Root Mean Square Error of Prediction (test set validation)
Range: min - max values.

Conclusion

The conclusion is that it has proved possible to predict the feed value in cereals with NIRS quickly and cheaply, but prediction error with this method is relatively high in relation to a chemical determination of the feed value. A further improvement of the NIRS method will probably be possible with the addition of further references (several years, varieties and sites), which is therefore recommended. Uncertainty of the chemical reference analyses has led to increased uncertainty of the NIRS method. The current model for prediction of grain feed value with NIRS is only suitable as a guiding rule.

Aarhus University
Faculty of Agricultural Sciences